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December 5, 2005
05471-L-001

Ms. Nancy Reimer
Donovan Hatem, LLP
Two Seaport Lane
Boston MA 02210

SUBJECT: Analysis of Flywheel Housing Failures

Dear Ms Reimer:

This letter serves as my report into the failure of the flywheel housings experienced by Trans-Spec Truck Service, Inc. It includes the results of inspections, laboratory evaluations and engineering analysis.

1.0 BACKGROUND

The flywheel housings in question are cast aluminum components designed and fabricated by Caterpillar and bolt on the rear end of their 3176, C10 and C12 diesel engines. The housing is attached using 12 M12 x 1.75 (metric dimension) bolts that are threaded into the cast iron engine block. The transmission then bolts on the other end of the flywheel housing. The 3176 engine was released in 1989 with the release of the C10 and C12 in 1994/95 timeframe. All of these engines use the same design aluminum flywheel housing utilizing the same bolting patterns. Therefore, the flywheel housings are interchangeable on all these engine models. Over the years the horse power and maximum torque ratings of the engines have evolved from 280 hp and 1050 ft-lbs of torque up to 430 hp and 1650 ft-lbs of torque. This constitutes a 54% increase in hp and a 57% increase in maximum torque over the years. The Trans-Spec trucks were rated at the higher horsepower and torque. No design modifications to the flywheel housings to account for these increases in horsepower and torque were identified nor was any testing performed on the housings to verify their suitability for these higher ratings.

Trans-Spec Truck Service, Inc. operated vehicles that contained these types of engines and flywheel housings. The vehicles were manufactured by Sterling Truck Corporation. Over the course of several years numerous flywheel housings have either cracked or had the bolts that attach the flywheel housing to the rear of the engine loosen necessitating replacement.

Altran Solutions was contracted to investigate the cause of these failures. This report summarizes the results of that investigation.

Ms. Nancy Reimer

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The last effect that has not been addressed by the Caterpillar analysis is the effect of temperature excursions on the bolted connection. This becomes an issue when there are different materials in the bolted connection that have different coefficients of thermal expansion. In this case, for a given temperature increase, the aluminum will expand about 1.6 times as much as the steel bolt. What this means is that the load on the bolt will increase, further increasing the likelihood of loosening, particularly when combined with the vibration effects and the combined loading effects. In this regard, a patent assigned to Caterpillar describes a new flywheel housing design that has a seal that is intended to overcome problems in aluminum flywheel housings associated with thermal expansion, relative movement between the housing and engine block, cracking or destroyed engine bolts. The Trans-Spec C10/12 flywheel housings do not incorporate this patented design feature.

The laboratory inspection of the flywheel housings also showed areas of anomalous wear patterns located below the circular openings and corresponding to the location of the oil pan on the bottom of the engine block. These wear patterns are visible in Figure 1 and in Figure 14. This wear is the result of contact and relative movement between the housing and the oil pan. These components should not be in contact during operation. Further, any contact between the components could transfer additional load to the bolted joint from the vibration experienced during normal operation adding additional loads to an inherently under-designed housing and connection. The fact that there is wear indicates that there was contact between the two components.

4.0 SUMMARY

The laboratory investigation revealed failures in aluminum C10/12 flywheel housings resulting from cracking and loosening bolts. The cracking of the housings was the result of fatigue in the area of the bolt holes. Further, anomalous wear was identified on the flywheel housing indicating contact and relative movement from the housing and engine oil pan. An engineering analysis of the flywheel housing and the bolted connection between the housing and the engine block revealed inherent design defects. It is my opinion that these design defects are: overstressing of the flywheel housings under normal operating conditions causing cracks to initiate and propagate; and an under-designed bolted connection resulting from improper joint design and unaccounted for torsional and thermal loads causing the bolts to loosen. These defects could be remedied by proper engineering design and analysis.

EXHIBIT

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Eckhian 1/24/06

December 7, 2005

Ms. Nancy Reimer
Donovan Hatem LLP
Two Seaport Lane
Boston MA 02210

Re: Analysis of Flywheel Housing Failures

Dear Ms. Reimer:

This letter serves as my report into the failure of the flywheel housings experienced by Trans-Spec Truck Service, Inc.

1. Background

During the period from late 1999 to early 2000, Tran-Spec took delivery of 22 Sterling trucks that were powered with Caterpillar C-12 engines. Trans-Spec had previously owned trucks that had been powered with Caterpillar 3176 engines. These vehicles were used primarily for the delivery of heating oil in the New England area.

The C-12 engines were delivered by Caterpillar with an aluminum flywheel housing that was intended to support the engine and the transmission. Although the trucks were built by Sterling, it is my understanding that Caterpillar approved the overall design of the truck and warrantied the C-12 engine system for 60 months/500,000 miles.

The flywheel housing is connected to the engine with twelve M12, 10.9 grade, bolts and to the transmission with 12 substantially smaller diameter bolts. The housing is aligned with the block by means of two dowels. The flywheel housing was also connected to the vehicle frame by means of two engine mounts.

Soon after delivery the flywheel housings started failing. These failures were characterized by the loosening of the bolts that connected the engine to the flywheel housing. The failures were also characterized by cracks developing in certain locations

Caterpillar made no effort to consider this issue in the only finite element analysis of the C-12 flywheel housing that I have observed. I have seen no data of tests run on vehicles in actual use that even attempted to measure temperature or strains and stresses in the flywheel housings.

I consider the failure analysis of this problem that I have observed by Caterpillar to be inadequate.

5. Summary of Conclusions

1. Aluminum flywheel housing supplied by and warrantied by Caterpillar to Trans-Spec failed.
2. Caterpillar had observed such failure in other engines and with other customers when aluminum housing was used.
3. Caterpillar knew that aluminum housing had a flaw that could cause failure such as those observed at Trans-Spec.
4. Caterpillar knew that changing the material of the housing to cast iron solved the problem in at least one case.
5. The design of the flywheel housing rendered the engine defective.
6. I have seen no basis that was offered by Caterpillar for rejecting Trans-Spec's warranty claims.
7. Caterpillar was obligated under the warranty to repair or replace defective engines and/or components. Alternatives that Caterpillar was aware of included the use of cast iron flywheel housings, the flywheel housing disclosed in the Caterpillar patent or the use of a metal plate under the bolt

heads as disclosed in Exhibit 12 of the Bowes Deposition. Caterpillar did not fulfill its obligations.

8. Rather than fulfill warranty obligations, Caterpillar instead performed inadequate tests that did not demonstrate the cause of the failure of its flywheel housings nor justified the denial of warranty claims.

6. Documents referred to or used:

Patent 6,065,757 and File Wrapper (attached)

Stewart and Stevenson information (attached)

Bowes and Colmer Depositions and Exhibits

Caterpillar-produced documents Bates numbered 1-4014

Caterpillar's Answers to Interrogatories and all attached exhibits

All documents produced by Trans-Spec to Caterpillar except for those maintained in a storage trailer at Trans-Spec's facility

Photographs taken of flywheel housings located at Caterpillar

Final Invoice/spec sheet produced by Minuteman Trucks, Inc. (attached)

7. List of Publications

See attached c.v.

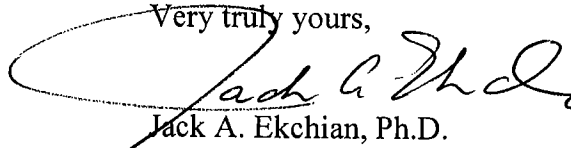
8. List of Cases in which I have testified as an expert at trial or by deposition

See attached c.v.

9. Compensation

\$ 300/hour.

Very truly yours,



Jack A. Ekchian, Ph.D.